A Portable X-Ray Computed Tomography Sysytem

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RESEARCH OBJECTIVES

Drilling boreholes is an expensive activity, whether conducted for environmental monitoring, resource extraction, or scientific purposes. Retrieving geologic samples (core) from the ground adds significantly to this expense, potentially doubling or tripling drilling costs. Beyond a geologist's visual inspection, much of the core often goes untouched. Frequently, core is subsampled for use in subsequent tests (such as oil/gas/water relative permeability). Some samples, such as those containing gas hydrates, change rapidly upon retrieval. In these cores, on-site core examination and evaluation is critical. Our objective in developing a portable x-ray computed tomography (CT) system is to (1) provide personnel in the field with a real-time comprehensive picture of core structure and (2) provide a tool for selecting subsamples.

Figure 1. Berkeley Lab's portable scanner has sailed the high seas and endured arctic cold, imaging more than 2,000 feet of core along the way.

APPROACH

Soil scientists and petroleum engineers have used x-ray CT to perform measurements on recovered core. The bulk of this work has been conducted using large medical scanners designed for imaging humans. These large, immobile systems, often costing a million dollars or more, are used in a laboratory and require water-cooling systems and air-conditioned lead-lined rooms. Our portable system had to be rugged, compact, lightweight, and fast. We were able to eliminate most of the weight by producing a novel multicomponent lead-shielding arrangement that reduced the footprint of the system and eliminated the need for a dedicated room. Special collimators and filters, optimized for geologic core, enabled us to use off-the-shelf industrial imagers and obtain results that rivaled the performance of expensive scientific instruments. As a result, our final product costs significantly less than the baseline medical technology that we set our sights on.

ACCOMPLISHMENTS

This unique portable x-ray CT scanner was fabricated in July 2002. Its first deployment was on Ocean Drilling Program (ODP) Leg 204 off the Oregon Coast, a research cruise to investigate methane-hydrate-bearing cores retrieved from Cascadia Ridge. Afterwards, the scanner was transported to the ODP Gulf Coast Core Repository, where it was used for follow-up studies. It was briefly back at Berkeley Lab to image hydrate dissociation experiments, before heading off for two months (March–April, 2003) to the Alaskan North Slope to image permafrost cores in another hydrate research project. The scanner will be used next for ODP Leg 210, a cruise to study the Newfoundland half of the Newfoundland-Iberia nonvolcanic rift.

SIGNIFICANCE OF FINDINGS

A portable x-ray CT system can provide geologists in the field with detailed information (such as density and macroporosity distribution) from recovered drill core. Additionally, subsamples can be selected knowing not just what is on the surface, but also the structure throughout the core. As a result of CT imaging, detailed structural information can be obtained quickly, and an electronic record can be generated. Ultimately, information will be extracted from recovered core quicker, with more precision, and at a lower cost.

RELATED PUBLICATION

Freifeld, B.M., T.J. Kneafsey, L. Tomutsa, and J. Pruess, Development of a portable x-ray computed tomographic imaging system for drill-site investigation of recovered core. Proceedings of the 2003 International Symposium of the Society of Core Analysts, Pau, France, September 21–24, 2003.

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